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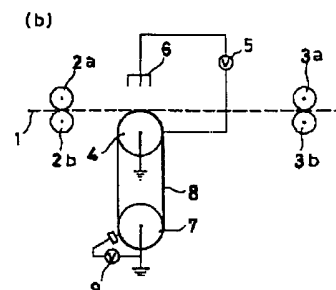
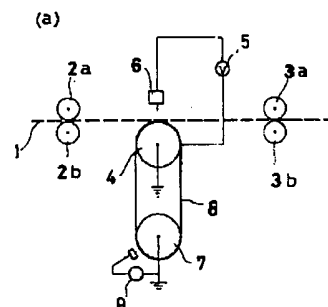
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(54) 【発明の名称】 エレクトレットフィルターの製造方法

(57) 【要約】

【目的】 優れた捕集効率を有するエレクトレットフィルターを高収率で製造することができる方法。

【構成】 高分子繊維集合体の上面および下面の少なくとも一方の面に高分子フィルム(B)を重ね、該高分子繊維集合体に荷電電圧を印加するとともに、高分子フィルム(B)に該荷電電圧とは逆の極性の電圧を印加して、高分子繊維集合体に荷電処理を施した後、高分子繊維集合体をエレクトレットフィルターに成形する工程を有する、エレクトレットフィルターの製造方法。



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【特許請求の範囲】

【請求項1】高分子繊維集合体の上面および下面の少なくとも一方の面に高分子フィルム(B)を重ね、該高分子繊維集合体に直流電圧を印加するとともに、高分子フィルム(B)に該荷電電圧とは逆の極性の電圧を印加して、高分子繊維集合体に荷電処理を施した後、高分子繊維集合体をエレクトレットフィルターに成形する工程を有する、エレクトレットフィルターの製造方法。

【請求項2】前記高分子繊維集合体が、高分子フィルムを解繊してなる平板状の解繊糸集合体である請求項1に記載のエレクトレットフィルターの製造方法。

【請求項3】前記高分子フィルム(B)が、高分子繊維集合体と重ね合わされる部分以外の箇所、前記高分子フィルム(B)に荷電電圧とは逆の極性の電圧を印加する請求項1または2に記載のエレクトレットフィルターの製造方法。

【請求項4】前記高分子フィルム(B)が、空隙率50%以下のフィルムである請求項1〜3のいずれかに記載のエレクトレットフィルターの製造方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明はエレクトレットフィルターの製造方法に関し、特に、優れた捕集効率を有するエレクトレットフィルターを高収率で製造することができる方法に関する。

【0002】

【従来の技術】原料樹脂を繊維状に成形した後、この繊維に針状、ワイヤー状、または板状の電極を用い荷電処理を施し、得られたエレクトレット化繊維状物を収集し、所望のフィルター形状に成形する工程によってエレクトレットフィルターを製造する方法、あるいは、溶融紡糸した繊維を延伸し、得られた延伸糸を緊張状態でコロナ放電を施す方法(特開昭60-199970号公報)、誘電性材料からなるウェブの少なくとも1面を誘電体フィルムで覆い、コロナ放電を施す方法(特開昭60-500658号公報)、不織布とアース電極の間に高誘電率の絶縁フィルムを配置し、コロナ放電を施す方法(特公昭59-15167号公報)などが知られている。また、フィルムに荷電処理を施した後繊維状にし、得られたエレクトレット化繊維状物を収集し、所望のフィルター形状に成形する工程によってエレクトレットフィルターを製造する方法等も知られている。

【0003】

【発明が解決しようとする課題】しかし、上記従来の方法では、繊維と繊維の空隙に電流が大量に流れることにより、電圧が上昇せず、荷電しようとする繊維が有効に荷電されない、また電圧を上げると放電が生じ十分なフィルター性能を得ることが困難であった。さらに、ウェブのように厚みのあるものの場合、その表面は効率良く荷電されるが、内部は表面と比べて荷電され難く、フィ

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ルターとしての性能が十分発揮されなかった。また、特開昭60-500658号公報、特公平59-15167号公報等に記載されているように、高分子フィルムで覆い荷電する方法は、荷電レベルは向上するが、経時的に、前記フィルムの帯電量が増加し、放電し易くなり、荷電効率が低下し、さらに捕集性能のバラツキが大きくなるという問題がある。フィルムに荷電処理を施した後繊維状にする方法では、フィルムの荷電時にフィルムの電極への密着性が増し、フィルム切れの原因となる。このフィルム切れが発生すると、フィルムが荷電されているため、フィルムがロール等に巻き付き易く、製造上のトラブルの原因となる。

【0004】そこで本発明の目的は、エレクトレットフィルターを形成するための繊維一本一本に効率的に荷電処理が可能であり、捕集効率等の各種性能に優れたエレクトレットフィルターを、製造上のトラブルがなく、安定して高収率で迅速に得ることができる方法を提供することにある。

【0005】

【課題を解決するための手段】前記課題を解決するために、本発明は、高分子繊維集合体の上面および下面の少なくとも一方の面に高分子フィルム(B)を重ね、該高分子繊維集合体に直流電圧を印加するとともに、高分子フィルム(B)に該荷電電圧とは逆の極性の電圧を印加して、高分子繊維集合体に荷電処理を施した後、高分子繊維集合体をエレクトレットフィルターに成形する工程を有する、エレクトレットフィルターの製造方法を提供するものである。

【0006】前記高分子繊維集合体が、高分子フィルムを解繊してなる平板状の解繊糸集合体であると、好ましい。

【0007】前記高分子フィルム(B)が、高分子繊維集合体と重ね合わされる部分以外の箇所、前記高分子フィルム(B)に荷電電圧とは逆の極性の電圧を印加するのが、有効である。

【0008】以下、本発明のエレクトレットフィルターの製造方法(以下、「本発明の方法」という)について詳細に説明する。

【0009】本発明の方法において、高分子繊維集合体を形成する高分子化合物は、極性高分子化合物、無極性高分子化合物のいずれのものでもよく、また、結晶性高分子化合物、無定形高分子化合物のいずれのものでもよい。また、1種単独の高分子化合物を使用してもよいし、2種以上の高分子化合物を混合して使用してもよい。

【0010】無極性高分子化合物としては、例えば、ポリエチレン、ポリプロピレン等のポリオレフィン、ポリスチレン、ポリ四フッ化エチレン、四フッ化エチレン・六フッ化プロピレン共重合体などが挙げられる。

【0011】また、極性高分子化合物としては、例え

ば、分子中に、カルボキシ基、エステル基、アミド基、水酸基、エーテル基、ニトリル基、カルボニル基、あるいは塩素原子等のハロゲン原子などの極性基を有するものである。この極性高分子化合物の具体例としては、ポリエチレンテレフタレート、ポリテトラメチレンテレフタレート等のポリエステル；ナイロン6、ナイロン66、ナイロン12等のポリアミド；ポリカーボネート、ポリメタクリル酸メチル、ポリアクリル酸エチル等のアクリル系樹脂；アクリルースチレン共重合体系樹脂（A S樹脂）、アクリルブタジエンスチレン共重合体系樹脂（A B S樹脂）、ポリ塩化ビニル、ポリ塩化ビニリデン、ポリ塩化三フッ化エチレン、ポリアセタール、ポリアクリルニトリルなどが挙げられる。

【0012】また、無極性高分子化合物に極性基を有するモノマーをグラフト共重合させた変性無極性高分子化合物も極性高分子化合物として使用できる。このような変性無極性高分子化合物は、前記無極性高分子化合物に、不飽和カルボン酸およびその誘導体から選ばれる少なくとも1種を、例えば、有機過酸化物等のラジカル重合開始剤の存在下に、グラフト共重合させたもの等がある。

【0013】グラフト変性に用いられる不飽和カルボン酸およびその誘導体としては、例えば、アクリル酸、メタクリル酸、 α -エチルアクリル酸等の不飽和モノカルボン酸；マレイン酸、フマル酸、イタコン酸、シトラコン酸、テトラヒドロフタル酸、メチルテトラヒドロフタル酸、エンドシス-ビスシクロ[2, 2, 1]ヘプト-5-エン-2, 3-ジカルボン酸（ナジック酸）、メチル-エンドシス-ビスシクロ[2, 2, 1]ヘプト-5-エン-2, 3-ジカルボン酸（メチルナジック酸）等の不飽和ジカルボン酸；これらの不飽和カルボン酸の酸ハライド、アミド、イミド、酸無水物、エステル等の不飽和カルボン酸の誘導体などが挙げられる。この不飽和ジカルボン酸の誘導体の具体例としては、塩化マレニル、マレイミド、無水マレイン酸、無水シトラコン酸、マレイン酸モノメチル、マレイン酸ジメチル等が挙げられる。これらの不飽和カルボン酸およびその誘導体は、1種単独でも2種以上を組合せても用いられる。本発明において、これらの中でも、不飽和ジカルボン酸およびその酸無水物が好ましく、特にマレイン酸、ナジック酸およびこれらの酸無水物が好ましい。

【0014】変性無極性高分子化合物において、これらの不飽和カルボン酸およびその誘導体の含有量、すなわち、変性無極性高分子化合物のグラフト変性量は、通常、0.05～15重量%程度、好ましくは0.5～5重量%程度である。

【0015】本発明の方法において、前記高分子化合物は1種単独あるいは2種以上混合してなる混合物を使用してもよい。前記高分子化合物の2種以上を混合して使用する場合には、極性高分子化合物同士または無極性高

分子化合物同士あるいは極性高分子化合物と無極性高分子化合物とを混合してもよい。また、極性高分子化合物の一部として変性無極性高分子化合物を使用してもよい。

【0016】無極性高分子化合物と極性高分子化合物を混合して用いる場合、その無極性高分子化合物/極性高分子化合物の混合割合は、重量比で60～99/0.5～39.5、好ましくは80～95/1～10である。また、極性高分子化合物の一部として変性無極性高分子化合物を用いる場合、その含有割合は、通常、組成物全量に対して0.5～20重量%程度であり、好ましくは4～10重量%程度である。

【0017】また、この高分子化合物とともに、必要に応じて、例えば、耐熱安定剤、耐候安定剤、帯電防止剤、スリッパ剤、アンチブロッキング剤、滑剤、無機あるいは有機の充填剤、染料、顔料等を使用してもよい。

【0018】本発明の方法は、これら高分子化合物からなる高分子繊維集合体を素材として用いるものである。この高分子繊維集合体は、前記高分子化合物からなる高分子フィルム（以下、「高分子フィルム（A）」という）を解繊したものでもよいし、前記高分子化合物を、溶融紡糸、湿式紡糸等の方法により、直接、繊維化したものでもよい。高分子繊維集合体が、高分子フィルム（A）を解繊してなる平板状の解繊系集合体である場合、その断面形状が長方形であり、円形断面の解繊系と比べて荷電効率が優れている点で、好ましい。また、該高分子フィルム（A）の製造の方法は、特に制限されず、通常、この種の樹脂からフィルムを成形する方法として利用されるいずれの方法も適用可能である。例えば、インフレーションフィルム成形法、T-ダイを用いる押出成形法、ロール圧延による方法などが挙げられる。このようにして得られる高分子フィルム（A）の厚さは、製品であるエレクトレットフィルターの目付量、圧損等が所望の値になるように、予め適宜選択することができる。通常、厚さが10～100 μ m程度であり、延伸倍率を6～10倍とするためには、20～50 μ m程度の厚さであるのが好ましい。

【0019】また、この高分子フィルム（A）を解繊して高分子繊維集合体を製造する方法は、特に制限されず、フィルムを延伸または延伸せずに、例えば、針山状ロール等の解繊機を使用して解繊して行うことができる。

【0020】高分子フィルム（A）の解繊において、フィルムを延伸する場合、延伸は、通常、高分子フィルム（A）を構成する高分子化合物の軟化点以上融点以下、例えば、110～150℃程度に加熱してロール、熱板、オープン等を用いて、フィルムの縦方向に行なわれる。このとき、延伸倍率は、通常、5～10倍程度であり、成形安定性が良好でその後の解繊が容易である点で、6～8倍程度が好ましい。

【0021】高分子フィルム(A)を解繊して得られる高分子繊維集合体は、紙管、ドラム等に巻き取ってから次工程に移送してもよいし、また、そのまま連続的に次工程に供給してもよい。

【0022】ここで、本発明の方法でいう高分子繊維集合体とは、製造方法によって、繊維が疎らな状態で平面状に分散している状態から、繊維が密に集積してシート状に形成されている状態までの、いずれの集合状態であるものを含む。

【0023】また、本発明の方法において、高分子繊維集合体を構成する繊維が、略四角形の断面形状をなす繊維であると、例えば、後段の荷電処理において解繊系が効率的に荷電されるため、好ましい。

【0024】本発明の方法は、以上の高分子化合物からなる高分子繊維集合体に荷電処理を施すに際して、該高分子繊維集合体の上面または下面の少なくとも1面に高分子フィルム(B)を重ね、該高分子繊維集合体に荷電電圧を印加するとともに、高分子フィルム(B)に該荷電電圧とは逆の極性の電圧を印加する方法である。

【0025】この高分子繊維集合体に重ねられる高分子フィルム(B)の材質としては、前述した極性高分子化合物、無極性高分子化合物のいずれのものでもよいし、また、無定型、結晶性のいずれのものでもよい。特に、高分子フィルム(B)として好ましいものは、滑り易さおよび高絶縁性という点からフッ素系樹脂フィルムである。

【0026】この高分子フィルム(B)の厚みは、荷電効率が良い点で、 $1 \sim 1000 \mu\text{m}$ 、好ましくは $5 \sim 50 \mu\text{m}$ の範囲である。

【0027】また、本発明の方法において、高分子繊維集合体と高分子フィルム(B)とを重ね合わせた状態で荷電処理を施す方法、および装置は、所定のエレクトレット化が可能な方法および装置であれば特に制限されない。

【0028】前記荷電装置において、荷電電極は針状、ワイヤー状等の電極が用いられ、また、荷電方法は、高分子繊維集合体にコロナ荷電を連続的または間欠的に加える方法などが用いられる。また、接地電極としては、針状、ワイヤー状、板状、ロール状等の電極が用いられる。

【0029】本発明の方法において、荷電処理される高分子繊維集合体に重ねられる高分子フィルム(B)に、前記高分子繊維集合体に印加される荷電電圧と逆の極性の電圧を印加する方法は、特に制限されず、例えば、コロナ放電等の方法によって行うことができる。また、高分子フィルム(B)に荷電電圧と逆の極性の電圧を印加する場所は、特に限定されないが、高分子フィルム(B)と、高分子繊維集合体とが重ね合わされる部分以外の箇所で、高分子フィルム(B)に荷電電圧とは逆の極性の電圧が印加されるようにすると、経時的に荷電効

率の低下が防止され、また、荷電時の放電の発生数も抑制され、生産性が向上する点で、好ましい。

【0030】本発明の方法において、高分子繊維集合体の上面または下面の少なくとも1面に高分子フィルム(B)を重ね、該高分子繊維集合体に直流電圧を印加するとともに、高分子フィルム(B)に該直流電圧とは逆の極性の直流電圧を印加して荷電処理を行う方法、および装置の好適な態様として、例えば、図1(a)および(b)、ならびに図2に示す装置が挙げられる。以下、この図1(a)および(b)、ならびに図2に示す装置について説明する。なお、図1(a)および(b)、ならびに図2において、同一の部材または箇所には同一の符号を付した。

【0031】図1(a)に示す荷電装置においては、解繊工程から移送されてきた高分子繊維集合体1は、ロール2aおよび2bによって荷電装置内に導入し、ロール3aおよび3bによって引き取られる。この高分子繊維集合体1は、ロール状の接地電極4と該接地電極4に対して直流電源5によって所定の電圧 V_1 に保持された針状の荷電電極6との間を通過し、荷電処理が施される。このとき、ロール状の接地電極4と、該接地電極4に対応して配設されたロール7とは、連動して回転し、該接地電極4とロール7の間に巻架された高分子フィルム(B)8は、移送されてくる高分子繊維集合体1の下面に重ね合わせられた状態で荷電処理が行われる。また、ロール7は接地され、高分子フィルム(B)8には、直流電源9によって前記直流電源5と逆の極性の直流電圧が印加された電極によって、荷電電極6と逆の極性の電圧が印加される。荷電処理後、ロール3aおよび3bによって、エレクトレット化された高分子繊維集合体1は、次の工程に移送される。

【0032】図1(b)に示す荷電装置においては、解繊工程から移送されてきた高分子繊維集合体1は、ロール2aおよび2bによって荷電装置内に導入し、ロール3aおよび3bによって引き取られる。高分子繊維集合体1は、ロール状の接地電極4と該接地電極4に対して直流電源5によって所定の電圧 V に保持されたワイヤ状の荷電電極6との間を通過し、荷電処理が施される。このとき、ロール状の接地電極4と、該接地電極4に対応して配設されたロール7とは、連動して回転し、該接地電極4とロール7の間に巻架された高分子フィルム(B)8は、移送されてくる高分子繊維集合体1の下面に重ね合わせられた状態で荷電処理が行われる。また、ロール7は接地され、高分子フィルム(B)8には、直流電源9によって前記直流電源5と逆の極性に直流電圧が付加された電極によって、荷電電極6と逆の電圧が印加される。荷電処理後、ロール3aおよび3bによって、エレクトレット化された高分子繊維集合体1は、次の工程に移送される。

【0033】また、図2に示す荷電装置においては、解

織工程から移送されてきた高分子繊維集合体1は、ロール状の接地電極4と該接地電極4に対して直流電源5によって所定の電圧Vに保持されたワイヤ状の荷電電極6との間を通過し、荷電処理が施される。このとき、ロール状の接地電極4に巻装され、直流電極9によって前記直流電源5と逆の極性に直流電圧が付加された電極によって、荷電電極6と逆の電圧が印加された高分子フィルム(B)8は、移送されてくる高分子繊維集合体1の下面に重ね合わせられた状態で荷電処理が行われる。また、ロール状の接地電極4は接地されている。この図2に示す装置は、高分子フィルムのズレ等によるしわの発生がないため、高速成形が可能となり、また、放電による高分子フィルムの切断が起こり難いため、生産安定性が向上する。

【0034】本発明の方法において、荷電処理を施すために、荷電電極と接地電極の間に印加される電圧は、通常、3~30kV程度であり、好ましくは5~15kV程度である。また、荷電電極と接地電極の間隔は、通常、3~30mm程度であり、好ましくは5~15mm程度である。さらに、両電極間における高分子繊維集合体の滞留時間は、通常、0.01~1秒程度である。さらに、荷電処理の際の周囲雰囲気温度は、特に限定されず、常温付近が好ましい。

【0035】本発明の方法においては、以上のようにして荷電処理された高分子繊維集合体を、例えば、カッターで90mmに切断し開綿機にかけて、エレクトレット化繊維を得ることができる。また、得られるエレクトレット化繊維は、解繊に供したフィルムの厚さ、延伸倍率、解繊の程度等を予め選択することにより、所望の太さにすることができる。また、用いられる開綿機は、特に限定されず、通常、この種の開綿工程に使用されるものでよい。

【0036】次に、得られるエレクトレット化繊維を収集し、所望の形状に成形して、エレクトレットフィルターを得ることができる。

【0037】エレクトレット化繊維の成形は、例えば、前記のようにして得られたエレクトレット化繊維を、常法にしたがって織成、編成、タフト化したり、あるいは不織布に成形することにより、製造することができる。例えば、ニードルパンチング、熱ボンディング、超音波ボンディング等の方法に従って、所望の性状の原反を製造することができる。

【0038】本発明の方法によって製造されるエレクトレットフィルターは、所定の寸法に裁断し、またはブリーツ状に折り込んだ形態で用いられる。このとき、エレクトレットフィルターは、単独で、または常用の不織布を常法にしたがって貼り合わせて用いることもできる。

【0039】本発明の製造方法によって得られるエレクトレットフィルターは、例えば、1 μ m以下の微粒子を効率よく捕集できる特長を生かして、エアフィルター、

空気清浄材、掃除機用フィルター、エアコン用フィルター、マスク等の用途に好適である。

【0040】

【実施例】以下、本発明の実施例および比較例を挙げて本発明を具体的に説明する。

【0041】(実施例1) ポリプロピレン(三井石油化学工業株式会社製、ハイボールB200、MFR:0.5g/10分)900g、ポリカーボネート(ゼネラルエレクトリック社製、レキサン101)500gおよび無水マレイン酸変性ポリプロピレン(無水マレイン酸グラフト変性量:3重量%)500gを混合して樹脂組成物を調製した。

【0042】得られた樹脂組成物を、インフレーションフィルム成形機(東芝機械(株)製)に供給して、240℃で、厚さ30 μ mのフィルムに成形した。次に、このフィルムを135℃で、長手方向に6.6倍の延伸倍率で熱板にて延伸しながら、針山状ロールに掛けて、網目状に解繊し、得られた解繊系の下面に厚み25 μ mのフッ素樹脂フィルム(FEP、ダイキン工業(株)製、ネオクロンNF-0025)を重ね、これを図1(a)に示す構成の荷電装置の荷電電極とロール状の接地電極との間(電極間隔:8mm)に滞留時間:0.5秒で通して、印加電圧:-9kV(直流)を印加してコロナ放電を供給して荷電処理を施した後、紙管に巻き取った。このとき、前記FEPフィルムに、+7kVの直流電圧を印加した。次に、紙管からエレクトレット化された解繊糸を巻きだし、カッターで90mmにカットした後、開綿機に掛けてエレクトレット化原綿を得た。

【0043】得られたエレクトレット化原綿をウェブ・フォーミング・マシンに供給してウェブに成形し、ニードルパンチングして、目付量:100g/m²、厚み:2mmのエレクトレットフィルターを製造した。この時の成形性を解繊糸の切れる回数および放電の発生回数で評価し、表1に示す。また、得られたエレクトレットフィルターの捕集効率を、下記の方法にしたがって測定した。結果を表1に示す。

【0044】捕集効率

図3に概略を示す測定装置を使用して捕集効率を測定した。まず、エアロゾル発生機(日本科学工業社製)21からNaCl粒子(粒径:0.3 μ m)を供給するとともに、エアフィルター22を通した清浄空気をチャンバー23に供給した。チャンバー23内のNaCl粒子濃度が一定濃度(2~6 $\times 10^6$ 個)となった後、プロワー24を作動させてチャンバー23内の気体を流通経路25を通じて流量調整バルブ26で流量を調整しながら吸引した。流速計27によって測定される流通速度が一定速度(0.5m/sec)となった時に、流通経路25に配設した、測定対象であるエレクトレットフィルター28の上流側および下流側におけるNaCl粒子濃度C_{in}およびC_{out}を、パーティクルカウンター(リオ

ン社製、KC-01B) 29aおよび29bによって、それぞれ測定した。下記式に基づいて捕集効率を算出した。

$$\text{捕集効率} = [1 - (C_{\text{out}} / C_{\text{in}})] \times 100 (\%)$$

【0045】(実施例2) 高分子繊維集合体の上面にFEPフィルムを重ね、FEPフィルムに+7.5kVの電圧を印加した他は実施例1と同様にしてエレクトレットフィルターを製造した。成形性および得られたエレクトレットフィルターの捕集効率を評価または測定した。結果を表1に示す。

【0046】(実施例3) FEPフィルムの代わりに厚み30μmのポリプロピレンフィルムを用い、前記ポリプロピレンフィルムに+7.5kVの電圧を印加した他は実施例1と同様にしてエレクトレットフィルターを製造した。成形性および得られたエレクトレットフィルターの捕集効率を評価または測定した。結果を表1に示す。

【0047】(実施例4) FEPフィルムの代わりに厚み50μmのカプトンフィルムを用い、前記カプトンフィルムに+7.5kVの電圧を印加した他は実施例1と同様にしてエレクトレットフィルターを製造した。成形性および得られたエレクトレットフィルターの捕集効率を評価または測定した。結果を表1に示す。

【0048】(実施例5) 実施例1と同様にして得られた解繊糸を、図2に示す荷電装置に供給して、針状の荷電電極、および厚さ25μmのフッ素樹脂フィルム(FEP)で覆ったロール状接地電極からなる電極間に、印加電圧:-8kV、電極間隔:8mm、滞留時間:0.5秒の条件で荷電処理を施した後、エレクトレット化された解繊糸を紙管に巻き取った。このとき、FEPフィルムには、+8kVの直流電圧を印加した。次に、エレクトレット化された解繊糸を、実施例1と同様に処理してエレクトレットフィルターを成形し、このときの成形性を評価し、さらに得られたエレクトレットフィルターの捕集効率を測定した。結果を表1に示す。

【0049】(実施例6) 高分子フィルムとして、厚さ30μmのポリプロピレンフィルム(三井石油化学工業(株)製、F301)を用いた以外は、実施例1と同様にしてエレクトレットフィルターを成形し、成形性を評

価し、さらに得られたエレクトレットフィルターの捕集効率を測定した。結果を表1に示す。

【0050】(実施例7) 高分子フィルムとして、厚さ50μmのカプトンフィルムを用い、荷電直流電圧:-9kV、カプトンフィルムに+8.5kVの直流電圧を印加した以外は、実施例1と同様にしてエレクトレットフィルターを成形し、成形性を評価し、さらに得られたエレクトレットフィルターの捕集効率を測定した。結果を表1に示す。

10 【0051】(実施例8) 高分子フィルムとして、厚さ30μmの多孔質ポリプロピレンフィルム(宇部興産製、PF2000、空隙率:20%)を用い、荷電直流電圧:-8.2kV、多孔質ポリプロピレンフィルムに+7.2kVの直流電圧を印加した以外は、実施例1と同様にしてエレクトレットフィルターを成形し、成形性を評価し、さらに得られたエレクトレットフィルターの捕集効率を測定した。結果を表1に示す。

【0052】(実施例9) 高分子フィルムとして、厚さ30μmの多孔質ポリプロピレンフィルム(宇部興産製、PF5010、空隙率:50%)を用い、荷電直流電圧:-8.2kV、多孔質ポリプロピレンフィルムに+7.2kVの直流電圧を印加した以外は、実施例1と同様にしてエレクトレットフィルターを成形し、成形性を評価し、さらに得られたエレクトレットフィルターの捕集効率を測定した。結果を表1に示す。

【0053】(比較例1) 実施例1において製造された延伸フィルムを解繊した後、そのまま電極に供給して荷電処理を施した以外は、実施例1と同様にして、エレクトレットフィルターを製造した。得られたエレクトレットフィルターの成形性および捕集効率を評価または測定した。結果を表1に示す。

【0054】(比較例2) 高分子フィルム(B)としてFEPフィルムを用いて解繊糸の下面を重ね、FEPフィルムにプラスの電圧を印加しなかった他は実施例1と同様にしてエレクトレットフィルターを製造した。得られたエレクトレットフィルターの成形性および捕集効率を評価または測定した。結果を表1に示す。

【0055】

表 1

試験	内 容	成形性	捕集効率 (%)	捕集効率のパ ラツキ σ_{s-1}
実施例1	FEPフィルム下面 逆荷電有り	○	58.3	4.1
実施例2	FEPフィルム上面 逆荷電有り	○	57.5	3.6
実施例3	PPフィルム下面 逆荷電有り	○'	59.1	3.9
実施例4	カプトンフィルム下面 逆荷電有り	○'	57.7	4.3
実施例5	FEPフィルム下面 逆荷電有り	○	63.7	2.0
実施例6	PPフィルム下面 逆荷電有り	○	55.7	3.6
実施例7	カプトンフィルム下面 逆荷電有り	○	55.4	3.7

【0056】

表 1 (つづき)

試験	内 容	成形性	捕集効率 (%)	捕集効率のパ ラツキ σ_{s-1}
実施例8	PP多孔質フィルム 下面 逆荷電有り (空隙率: 20%)	○	55.4	3.4
実施例9	PP多孔質フィルム 下面 逆荷電有り (空隙率: 20%)	○	43.7	3.1
比較例1	フィルム無し	○'	40.6	3.5
比較例2	FEPフィルム下面 逆荷電無し	△ 放電有り	51.0	7.1

【0057】

【発明の効果】本発明の方法によれば、従来法では達成し得ないレベルの捕集効率等の各種性能に優れたエレクトレットフィルターを、従来法におけるような製造上の

トラブルを生じることなく、安定して高効率で迅速に製造することができる。

【図面の簡単な説明】

【図1】 (a) および (b) はそれぞれ荷電処理に用

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いる装置の構成を示す概略図。

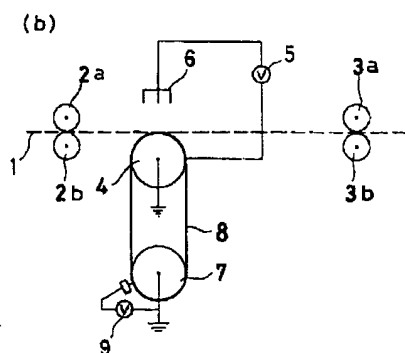
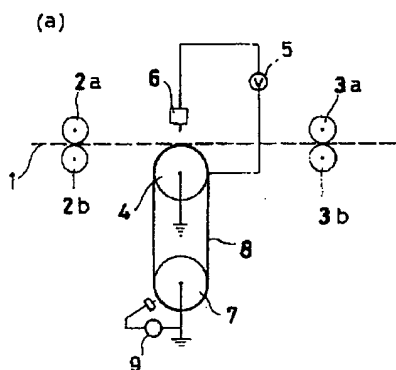
【図2】 荷電処理に用いる装置の他の構成を示す概略図。

【図3】 捕集効率の測定に用いた装置の構成を示す概略図。

【符号の説明】

- 1 高分子繊維集合体
- 2 a, 2 b ロール
- 3 a, 3 b ロール
- 4 接地電極
- 5 直流電源
- 6 荷電電極

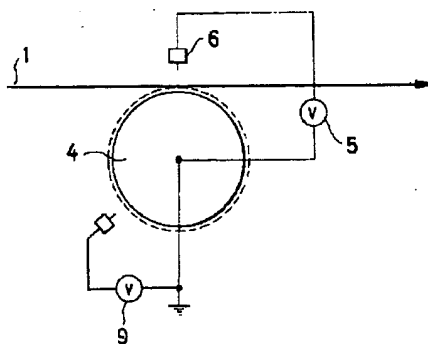
【図1】



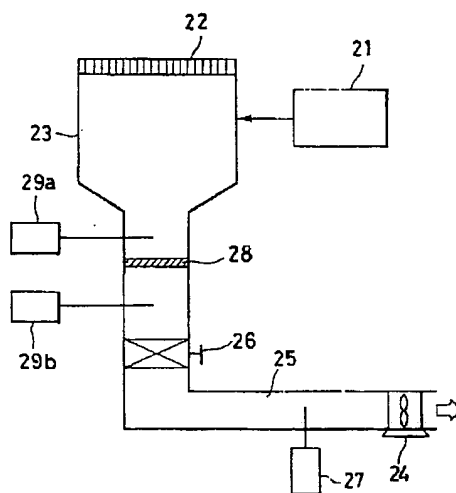
14

- 7 ロール
- 8 高分子フィルム (B)
- 9 直流電源
- 21 エアロゾル発生機
- 22 エアーフィルター
- 23 チャンバー
- 24 ブロワー
- 25 流通経路
- 26 流量調整バルブ
- 27 流速計
- 28 エレクトレットフィルター
- 29 a, 29 b パーティクルカウンター

【図2】



【図3】



[Note: Names, addresses, company names and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified by a numeral prefix or a general form of plurality suffix.]

(54) [Name of the Invention]

Method for Production of Electret Filter

(57) [Abstract]

[Goal]

The goal of the present invention is to suggest a method that allows the high yield manufacturing of electret filter with a high collecting efficiency.

[Structure]

Electret filter manufacturing method consisting of the technological processes where a polymer film (B) is applied to at least one surface, either the upper surface or the lower surface, of a polymer fiber aggregate, and a direct electric current is applied to the above described polymer fiber aggregate and together with that a voltage with a polarity that is opposite to that of the above described charge voltage is applied onto the polymer film (B), and a charge treatment is applied to the polymer fiber aggregate and then the polymer fiber aggregate is formed into an electret filter.

[Claims of the Invention]

[Claim 1] Method for production of electret filter comprising a process wherein a polymer film (B) is applied to at least one surface, either the upper surface or lower surface, of a polymer fiber aggregate, a direct current is applied to the above-mentioned polymer fiber aggregate, and at the same time, a voltage with a polarity opposite to that of the above-mentioned charge voltage is applied to polymer film (B) and a charge treatment is applied to the polymer fiber aggregate and the polymer fiber aggregate is subsequently formed into an electret filter.

[Claim 2] The method for production of an electret filter described in Claim 1 wherein the above-mentioned polymer fiber aggregate is a flat split yarn aggregate produced by splitting a polymer film.

[Claim 3] The method for production of an electret filter described in Claim 1 or Claim 2 wherein a voltage with a polarity opposite that of the charge voltage is applied to the abovementioned polymer film (B) in areas other than the area where the polymer film (B) is applied to the polymer fiber aggregate.

[Claim 4] The method for production of an electret filter described in one of Claims 1 through 3 wherein the above-mentioned polymer film (B) is a film with a porosity of 50% or below.

[Detailed Explanation of the Invention]

[0001]

[Technical Field of the Invention]

The present invention is an invention about a method a manufacturing method for the production of electret filter, and in more details, it is about a manufacturing method for the production of electret filter that allows the high yield manufacturing of electret filter with a high collecting efficiency.

[0002]

[Previous Technology]

The method where an electret filter is manufactured by the technological processes where the raw material resin is formed into fiber shape and after that by using needle-shaped, wire-shaped or plate-shaped electrodes, an electrical charge treatment is conducted, and the obtained electretized fiber material is aggregated and it is formed into the predetermined filter shape; or the method where the material is melted and fiber spun, and the obtained spun fiber is subjected to corona electric discharge treatment under tension (reported in the description of the Japanese Patent Application Laid Open Number Showa 60-199970); the method where at least one surface of a web that is formed from dielectric material is covered by a dielectric material film and a corona electric discharge treatment is conducted (reported in the description of the Japanese Patent Application Laid Open Number Showa 60-500658); the method where an insulating film with a high dielectric coefficient is placed in the space between a nonwoven fabric and a grounding electrode, and a corona electric discharge treatment is conducted (reported in the description of the Japanese Patent Report Number Showa 59-15167), etc. Also, the method is known where after conducting an electro-charging treatment on the film it is formed into a fiber shape and the obtained electretized fiber material is combined and it is formed into the predetermined filter shape and by that the electret filter is obtained.

[0003]

[Problem Solved by the Present Invention]

However, according to the above described methods used in the past, a large amount of electric current flows in the fiber to fiber gaps and by that, it is not possible to efficiently electrically charge the fibers without an increase of the electrical voltage, and also, if the electric voltage is increased, an electric discharge is generated and it has been difficult to

obtain sufficient filter performance. Then, in the case when of material that has a web-like thickness, its surface is electrically charged at a good efficiency, however, the electro-charging of the inner part is difficult compared to that of the surface, and that material has not sufficiently demonstrated performance as a filter. Also, as it has been reported in the descriptions of the Japanese Patent Application Laid Open Number Showa 60-500658, Japanese Patent Report Number Showa 59-15167, in the case of the method where it is covered by a polymer film and electro-charged, the electrical charge level is increased, however, with the passing of the time, the amount of the electric charge in the above described film increases, and it becomes easy for an electric discharge to occur, and the electric charge efficiency is decreased, and then there has been the problem that it has been said that the variation of the collecting performance becomes large. In the case of the method where an electric charge treatment is performed on the film and after that it is made into fiber shape, at the time of the electro-charging of the film, the adhesive properties of the of the film relative to the electrode are increased, and that becomes a cause for film breaks. If such film breaks are generated, it becomes a source for trouble in the manufacturing process where the film is wound on a roll etc., in order to conduct the electro-charging process.

[0004]

Then, the goal of the present invention is to suggest a method where there are no manufacturing troubles, and whereby it is possible to obtain stably, at a high yield and at a fast rate, electret filter where it becomes possible to efficiently conduct the electro-charging treatment on the fibers one – on – one, in order to form an electret filter, and which has excellent collecting efficiency etc., different types of performance properties.

[0005]

[Measures in Order to Solve the Problems]

In order to solve the above described problems, the present invention is an invention that suggests an electret filter manufacturing method consisting of the technological processes where a polymer film (B) is applied to at least one surface, either the upper surface or the lower surface, of a polymer fiber aggregate, a direct electric current is applied to the above described polymer fiber aggregate and together with that a voltage with a polarity that is opposite to that of the above described charge voltage is applied onto the polymer film (B), and a charge treatment is applied to the polymer fiber aggregate and then the polymer fiber aggregate is formed into an electret filter.

[0006]

It is preferred that the above described polymer fiber aggregate material is a flat plate shaped loose (disentangled) fiber aggregate material that is obtained as a polymer film is made into loose fibers.

[0007]

It is effective if the above described polymer film (B) is subjected to an electric voltage with a polarity that is opposite the electro-charging electric voltage on the above described polymer film (B), at locations other than the parts where it is stacked and combined with the polymer fiber aggregate.

[0008]

Here below, a detailed explanation will be provided regarding the manufacturing method for the production of the electret filter according to the present invention (here below called "method according to the present invention").

[0009]

According to the method of the present invention, for the polymer compound that is used for the formation of the polymer fiber aggregate material, it is a good option if either a polar polymer compound or a non-polar polymer compound is used, and also, it is a good option if either a crystalline polymer material or a irregular shape polymer material, is used. Also, it is a good option if only one type of the polymer compound is used, and also it is a good option if two or more types of polymer materials are mixed, combined and used.

[0010]

As the non-polar polymer compounds, for example, it is possible to list the following materials: polyethylene, polypropylene, etc., poly olefins, polystyrene, poly tetrafluorinated ethylene, tetrafluorinated ethylene – hexa fluorinated propylene copolymer materials, etc.

[0011]

Also, as the polar polymer compounds, for example, it is possible to use compounds that contain in its molecule carboxylic radicals, ester radicals, amide radicals, hydroxyl radicals, nitrile radicals, carbonyl radicals, or chlorine atom etc., halogen atoms etc., polar radicals. As detailed examples of these polar polymer compounds it is possible to list the following materials: poly ethylene terephthalate, poly tetra methylene terephthalate, etc., polyesters; Nylon 6, Nylon 66, Nylon 12, etc., polyamides; polycarbonate, poly methyl methacrylate, poly ethyl acrylate, etc., acrylic type resins; acryl – styrene copolymer material type resins (AS resins), acryl – butadiene – styrene copolymer type resins (ABS resins); polyvinyl chloride, polyvinylidene chloride, poly chlorinated trifluorinated ethylene, polyacetal, poly acrylonitrile, etc.

[0012]

Also, modified non-polar polymer materials obtained by graft copolymerization of monomers that contain polar radical(s) onto non-polar polymer compounds, can be used

also as polar polymer compounds. Regarding such modified non-polar polymer materials, they are materials where on the above described non-polar polymer compounds, at least one type compound selected from the group of unsaturated carboxylic acids and their derivative materials, is graft copolymerized under the presence of, for example, organic peroxide etc., radical polymerization initiation agents, etc., materials.

[0013]

As the unsaturated carboxylic acids and their derivative materials that are used in the graft modification, for example, it is possible to list the following materials: acrylic acid, methacrylic acid, α -ethyl acrylic acid, etc., unsaturated monocarboxylic acids; maleic acid, fumaric acid, itaconic acid, citraconic acid, tetrahydro phthalic acid, methyl tetra hydro phthalic acid, methyl tetra hydro phthalic acid, end cis - bicyclo [2,2,1] hepto-5-en-2, 3 - dicarboxylic acid (najic acid), methyl - end- cis - bicyclo [2, 2, 1] hepto - 5- en - 2, 3 - dicarboxylic acid (methyl najic acid), etc., unsaturated dicarboxylic acid; acid halides of these unsaturated carboxylic acids, amides, imides, anhydrides, esters, etc., derivatives of the unsaturated carboxylic acids, etc. As detailed examples of these derivatives of the unsaturated carboxylic acids, it is possible to use malenyl chlorides, maleimides, anhydrous maleic acid, anhydrous citraconic acid, mono methyl maleate, dimethyl maleate, etc. These unsaturated carboxylic acids and their derivative materials can be used as one type of material only, or they can be used as a combination of two or more types of materials. According to the present invention, among these, as the preferred unsaturated dicarboxylic acids and their anhydrides, and especially, maleic acid, najic acid and their anhydrides, are preferred.

[0014]

Regarding the contained amount of these unsaturated carboxylic acids and their derivative materials in these modified non-polar polymer compounds, namely, regarding the graft modifier contained amount in the modified non-polar polymer compound, usually, it is at a level in the range of 0.05 ~ 15 weight %, and preferably, it is in the range of 0.5 ~ 5 weight %.

[0015]

According to the method of the present invention, it is also a good option if the above described polymer compound is a single type of material or also if it is a mixed material obtained by the combination of two or more types of materials. In the case when two or more types of the above described polymer compounds are mixed and used, it is also a good option if the polar polymer compounds are mixed with each other, or if the non-polar polymer compounds are mixed with each other, or if a polar polymer compound and a non-polar polymer compound, are mixed with each other. Also, it is a good option if a modified non-polar polymer compound is used as one part of the polar polymer compound.

[0016]

In the case when a non-polar polymer compound and a polar polymer compound are mixed and used, the ratio of the non-polar polymer compound/polar polymer compound is in the range of 60 ~ 99/0.5 ~ 39.5, preferably, it is in the range of 80 ~ 95/ 1 ~ 10, as a weight ratio. Also, in the case when a modified non-polar polymer compound is used as one part of the polar polymer compound, its content proportion is usually at a level in the range of 0.5 ~ 20 weight %, relative to the weight of the composition material, and preferably, it is at a level in the range of 4 ~ 10 weight %.

[0017]

Also, together with these polymer compounds, optionally (depending on the requirements), it is also possible to use, for example, thermal resistance stabilization agents, weather resistance agents, anti-electrostatic agents, slip agents, anti-blocking agents, lubricant agents, inorganic or organic filler agents, dye materials, pigment materials, etc.

[0018]

Regarding the method according to the present invention, it is an invention where the polymer fiber aggregate material formed from these polymer compounds, is used as a fiber material. Regarding this polymer fiber aggregate material, it is a good option if a polymer film formed from the above described polymer compounds (here below, called "polymer film (A)"), is made into loose (disentangled) fibers, and it is also a good option if the above described polymer compounds are directly fiber spun through melt fiber spinning, wet method fiber spinning etc., methods. In the case when the polymer fiber aggregate material is a flat plate shaped, loose fiber aggregate material formed from loose fibers of the polymer film (A), the shape of their cross section is a rectangular shape, and compared to the case of loose fibers where the shape of the cross section is a circular shape, the electro-charging efficiency is excellent, and from that point of view it is a preferred option. Also, there are no particular limitations regarding the manufacturing method for the preparation of the above described polymer film (A), and usually, it is possible to use any of the methods that are used as methods for the formation of films from these types of resin materials. For example, it is possible to use the inflation film forming method, the T-die extrusion method, the roll pressure spreading method, etc. Regarding the thickness of the polymer film (A) that is obtained by these methods, it can be appropriately determined in advance so that the predetermined values of the weight by surface area, the pressure loss etc., of the electret filter manufactured product, be achieved. Usually, the thickness is at a level in the range of 10 ~ 100 microns, and in order to make the orientation ratio be within the range of 6 ~ 10 times, it is a preferred to be a material with a thickness in the range of 20 ~ 50 microns.

[0019]

Also, regarding the manufacturing method for the preparation of polymer fiber aggregate material where this polymer film (A) is made into loose fibers, there are no particular

limitations, and with or without film orientation (stretching), for example, by using a "pincushion" shaped roll, etc., loose fiber equipment, it is made into loose fibers.

[0020]

Regarding the loose fibers of the polymer film (A), in the case of oriented film, the orientation can be conducted usually, by using heated at a temperature at or above the softening point of the polymer compound forming the structure of the polymer film (A), for example, a temperature in the range of 110 ~ 150°C, rolls, heating plates, ovens, etc., and conducting the orientation of the film in the longitudinal direction. At this time, the orientation coefficient is usually, in the range of 5 ~ 10 times, and from the point of view of the goodness of the formation stability properties and the ease of the loose fibers after that, it is preferred that the level of the orientation ratio be within the range of 6 ~ 8.

[0021]

Regarding the polymer fiber aggregate material obtained as the polymer film (A) is made into loose fibers, it is also a good option if it is taken out on a paper tube, drum, etc., and after that it is supplied to the subsequent technological processes. Also, it is also a good option if it is supplied to these subsequent technological processes in the state as it is.

[0022]

Then, as the polymer fiber aggregate material stated according to the present invention, depending on the manufacturing method, materials with any aggregate state from the aggregate state where bunches of fibers are dispersed on a flat surface shape, to an aggregate state where fibers are densely stacked and formed into a sheet shape, are included.

[0023]

Also, according to the method of the present invention, if the fibers that form the structure of the polymer fiber aggregate material, are fibers that have a cross section shape of small rectangular, for example, are preferred from the point of view of the efficient electro-charging of the loose fibers in the subsequent stage electro-charge treatment.

[0024]

Regarding the method according to the present invention, it is a method where a polymer film (B) is applied to at least one surface, either the upper surface or the lower surface, of a polymer fiber aggregate, a direct electric current is applied to the above described polymer fiber aggregate and together with that a voltage with a polarity that is opposite to that of the above described charge voltage is applied onto the polymer film (B), and a charge treatment is applied to the polymer fiber aggregate and then the polymer fiber aggregate is formed into an electret filter.

[0025]

As the material for the polymer film (B) that is placed on this polymer fiber aggregate material, it is a good option if any of the above described polar polymer compounds, non-polar polymer compounds, are used, and also, it is a good option if these are irregular shape type or crystalline type materials. Especially, as preferred materials for the above described polymer film (B), fluorine type resin films are preferred from the point of view of the fact that they are said to have easy slipping properties and high insulation properties.

[0026]

Regarding the thickness of this polymer film (B), from the point of view of the efficiency of the electrical charging, it is preferred that it be within the range of 1 ~ 1000 microns, and preferably, within the range of 5 ~ 50 microns.

[0027]

Also, in the method according to the present invention, regarding the method and the equipment for the conducting of the electrical charging treatment in the state where the polymer fiber aggregate material and the polymer film (B) are stacked, there are no particular limitations as long as it is a method and equipment that enables the predetermined electretization.

[0028]

In the above described electric charging equipment, as the electric charge electrode needle shaped, wire shaped, etc., electrodes can be used, and also, regarding the electro-charging method, the methods where a corona electric charge is applied continuously or intermittently to the polymer fiber aggregate material, can be used. Also, as the grounding electrode, it is possible to use needle shaped, wire shaped, plate shaped, roll shaped etc., electrodes.

[0029]

According to the method of the present invention there are no particular limitations regarding the method of applying an electric voltage with a polarity that is opposite to that of the above described charge voltage onto the polymer film (B), and a charge treatment is applied to the polymer fiber aggregate and then the polymer fiber aggregate is formed into an electret filter. And for example, it can be conducted by a corona electric discharge etc., methods. Also, regarding the location where the electric voltage with a polarity opposite to the electro-charging electric voltage is applied onto the polymer film (B), there are no particular limitations, however, if the electric voltage with a polarity opposite to the electro-charging electric voltage is applied onto the polymer film (B), is applied onto the locations outside of the part where the polymer film (B) and the polymer

fiber aggregate material are stacked, it is preferred from the point of view of the fact that the decrease of the electric charge efficiency with the passing of the time is eliminated, and also, from the point of view that the number of the incidents where electric discharge is generated at the time of the electric charge is also suppressed, and the manufacturing productivity properties are improved.

[0030]

According to the method of the present invention, as appropriate conditions of the method and the equipment used for the conducting of the treatment where a direct electric current is applied to the above described polymer fiber aggregate and together with that a voltage with a polarity that is opposite to that of the above described charge voltage is applied onto the polymer film (B), and a charge treatment is applied to the polymer fiber aggregate, for example, it is possible to use the equipment that is shown in Figure 1 (a) and (b) and together with that shown in Figure 2. Here below an explanation will be provided regarding the equipment that is shown in Figure 1 (a) and (b) and together with that in Figure 2. Moreover, for Figure 1(a) and 1 (b) and together with that Figure 2, the same parts or locations are designated by the same symbols.

[0031]

Regarding the electric charge equipment shown in Figure 1 (a), regarding the polymer fiber aggregate material 1 that can be transferred from the fiber disentanglement technological process, through the roll 2a and 2b, it is inserted in the electric charge device, and through the rolls 3a and 3b it is taken out. This polymer fiber aggregate material 1 is passed in the gap between the roll shaped grounding electrode 4 and the needle shaped electro-charging electrode 6, which is maintained at a predetermined electric voltage V1 through the direct electric current source 5 relative to the above grounding electrode 4, and the electro-charging treatment can be conducted. At this time, the roll shaped grounding electrode 4 and the roll 7, which is positioned in correspondence to the above grounding electrode 4, are moving and rotating, and the polymer film (B) 8 that is wound in the space between the above grounding electrode 4 and the roll 7, is transferred and in a state as it is laminated and combined at the lower surface of the polymer fiber aggregate material 1, an electro-charging treatment can be conducted. Also, the roll 7 is grounded and on the polymer film (B) 8, an electric voltage is applied with a polarity that is opposite to that of the electro-charging electrode 6, through an electrode where a direct current electric voltage is applied with a polarity that is opposite to the above described direct electric current source 5 from a direct electric current source 9. After the electro-charging treatment, through the rolls 3 a and 3 b, the electretized polymer fiber aggregate material 1 is transferred to the subsequent technological processes.

[0032]

In the electro-charging device shown in Figure 1 (b), the polymer fiber aggregate material 1 that can be transferred from the fiber disentanglement technological process, is inserted

inside the electro-charging equipment through the roll 2 a and 2 b, and it is taken out through the roll 3 a and 3 b. The polymer fiber aggregate material 1 is passed in the gap between the roll shaped grounding electrode 4 and the wire shaped electro-charging electrode 6 maintaining a predetermined electric voltage V through the direct electric current source 5 relative to the above grounding electrode 4, and the electro-charging treatment is conducted. At this time, the roll shaped grounding electrode 4, are moving and rotating, and the polymer film (B) 8 that is wound in the space between the above grounding electrode 4 and the roll 7, is transferred and in a state as it is laminated and combined at the lower surface of the polymer fiber aggregate material 1, an electro-charging treatment can be conducted. Also, the roll 7 is grounded and on the polymer film (B) 8, an electric voltage is applied with a polarity that is opposite to that of the electro-charging electrode 6, through an electrode where a direct current electric voltage is applied with a polarity that is opposite to the above described direct electric current source 5 from a direct electric current source 9. After the electro-charging treatment, through the rolls 3 a and 3 b, the electretized polymer fiber aggregate material 1 is transferred to the subsequent technological processes.

[0033]

Also, in the electro-charging device shown in Figure 2, the polymer fiber aggregate material 1 that can be transferred from the fiber disentanglement technological process is passed in the gap between the roll shaped grounding electrode 4 and the wire shaped electro-charging electrode 6 maintaining a predetermined electric voltage V through the direct electric current source 5 relative to the above grounding electrode 4, and the electro-charging treatment is conducted. At this time, the polymer film (B) 8 that is wound on the grounding electrode 4 and the roll 7, and that is subjected to an electric voltage opposite to the electro-charging electrode 6 through the electrode on which a direct electric current with polarity opposite to the above described direct electric current source 5 has been applied from a direct electric current electrode 9, is transferred and in a state as it is laminated and combined at the lower surface of the polymer fiber aggregate material 1, an electro-charging treatment can be conducted. Also, the roll shaped grounding electrode 4 is grounded. Regarding this equipment shown according to Figure 2, because of the fact that there is no generation of wrinkles due to polymer film variation etc., a high-speed formation becomes possible, and also, because of the fact that it is difficult for polymer film breakage due to electric discharge to occur, the production stability properties are improved.

[0034]

Regarding the electric voltage applied in the gap between the electro-charging electrode and the grounding electrode in order to conduct the electro-charging treatment according to the method of the present invention, usually, it is at a level in the range of 3 ~ 30 kV, and preferably, it is at a level in the range of 5 ~ 15 kV. Also, regarding the gap between the electro-charging electrode and the grounding electrode, usually, it is in the range of 3 ~ 30 mm, and preferably it is in the range of 5 ~ 15 mm. Then, regarding the residence

time period of the polymer fiber aggregate material in the gap between the two electrodes, usually, it is in the range of 0.01 ~ 1 seconds. Then, regarding the temperature of the ambient atmosphere at the time of the conducting of the electro-charging treatment, there are no specific limitations, and it is preferred to be conducted at temperatures close to normal (room) temperature.

[0035]

According to the method of the present invention, the polymer fiber aggregate material that has been subjected to an electro-charge treatment according to the above described, for example, by using a cutter, it is cut into 90 mm, and it is placed in a ray generating device and it is possible to obtain electretized fibers. Also, regarding the obtained electretized fibers, by the preliminary selection of the thickness, the orientation (stretching) ratio, the level of disentanglement etc., of the film that is supplied for the disentangled fibers, it is possible to achieve the desired thickness. Also, regarding the used ray-generating device, there are no particular limitations, and usually, it is a good option if this type of ray generating device is used.

[0036]

After that, the obtained electretized fibers are collected and formed into the predetermined shape, and it is possible to obtain the electretized filter.

[0037]

Regarding the formation of the electretized fibers, for example, it is possible to conduct the manufacturing as the electretized fibers obtained according to the above described process, are woven, knit, tufted according to the usual methods, or a nonwoven fabric material is formed. For example, by using the needle punching method, the heat bonding method, the ultra-sound bonding method, etc., methods, it is possible to manufacture the raw sheet with the predetermined shape.

[0038]

Regarding the electret filter manufactured according to the method of the present invention, it is cut into the predetermined dimensions or it can be used in a state where it is folded in pleats and it can be used in that shape. At this time, the electret filter can be used individually, or it is also possible that these can be glued and bonded together by following the usual nonwoven fabric methods.

[0039]

Regarding the electret filter manufactured according to the manufacturing method of the present invention, for example, it has the characteristic that it can collect at a good efficiency fine particles with a size of 1 micron or lower, and it can be appropriately used

as air filter, air purifying material, filter used in sweeping (cleaning) devices, filters used in air compressors, masks etc., applications.

[0040]

[Practical Examples]

Here below, practical embodiment examples and reference examples of the present invention will be presented and by that the present invention will be explained in further detail.

[0041] Application Example 1

Mixing was provided for 9000 g of polypropylene (Hi-Pole B200, product of Mitsui Petrochemical Ind., Ltd., MFR: 0.5 g/10 minutes), 500 g of polycarbonate (Lexane 101, product of General Electric Co.) and 500 g of maleic anhydride modified polypropylene (maleic anhydride graft modification ratio: 3 wt%) and a resin composition was produced.

[0042] The resin composition produced was fed to an inflation film molding machine (product of Toshiba Ltd.) and formed into a film with a thickness of 30 μm at a temperature of 240 $^{\circ}\text{C}$. Subsequently, the film was passed through a needle-punch roll as drawing of the abovementioned film was done in the longitudinal direction at a drawing ratio of 6.6 times on a hot plate at 135 $^{\circ}\text{C}$ to form a split yarn; then, a fluorine resin film (FEP, Neokron NF-0025, product of Daikin Ind., Ltd.) with a thickness of 25 μm was applied to the lower surface of the split yarn produced, the laminate produced was then passed through the charge electrode and a roll-like ground electrode (separation of electrodes: 8 mm) of the loading device with the structure shown in Fig. 1(a) at a retention time of 0.5 seconds and charge voltage of -9 kV (DC) was applied and corona discharge was applied and received on a paper roll. At this time, a DC voltage of +7 kV was applied to the above-mentioned FEP film. Subsequently, the electret-treated split yarn was rolled out from the paper roll and cut to 90 mm by a cutter, and a processed by means of a cotton opener to produce an electret-treated raw stock.

[0043] The electret-treated raw stock was then supplied to a web forming machine and formed into a web, then, needle-punching was performed to produce an electret filter with a metsuke of 100 g/m² and a thickness of 2 mm. The molding characteristics at the time were evaluated by the number of ruptures of the split yarn and number of occurrences of discharge and the results obtained are shown in Table 1 below. Furthermore, the collection efficiency of the electret filter produced was measured according to the method explained below. And the results obtained are shown in Table I as well.

[0044] Collection efficiency

Measurement was performed for the collection efficiency using the measurement device shown in Fig. 3. First, NaCl particle (particle diameter: 0.3 μm) was supplied from an aerosol generator (product of Japan Science Industry) 21 and at the same time, purified

air passed through air filter 22 was supplied to chamber 23. When a specific concentration of NaCl particles inside chamber 23 (2.6×10^6 particles) was achieved, blower 24 was turned on and the gas inside the chamber 23 was drawn via flow path 25 while the flow rate was being monitored by flow adjustment valve 26. When the flow velocity measured by the current meter 27 reached a constant rate (0.5 m/sec), measurement of NaCl particle concentration C_{in} and C_{out} up stream and down stream from the electret filter 28 being measured and arranged in flow path 25 was done using particle counters (KC-01B, product of Rion Co.) 29a and 29b, respectively. Calculation of the collection efficiency was done according to the formula shown below.

$$\text{Collection efficiency} = [1 - (C_{out}/C_{in})] \times 100 (\%)$$

[0045] Application Example 2

An FEP film was applied to the upper surface of the polymer fiber aggregate and a +7.5 kV voltage was applied to the FEP film and an electret filter was produced as in Application Example 1. An evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0046] Application Example 3

Instead of the FEP film, a polypropylene film with a thickness of 30 μm was used and a +7.5 kV voltage was applied to the polypropylene film and an electret filter was produced as in Application Example 1. An evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0047] Application Example 4

Instead of an FEP film, a capton film with a thickness of 50 μm was used and a +7.5 kV voltage was applied to the capton film and an electret filter was produced as in Application Example 1. An evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I. An evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0048] Application Example 5

A split yarn produced as in Application Example 1 was supplied to the loading machine shown in Fig. 2 and a charge treatment was applied to the space between the electrodes consisting of a needle-like charge electrode and a roll-like ground electrode coated with a fluorine resin film (FEP) with a thickness of 25 μm under conditions consisting of a charge voltage of -8 kV, electrode distance of 8 mm, and a retention time of 0.5 seconds, and the split yarn treated with an electret treatment was received on a paper roll. At this time, a DC current of +8 kV was applied to the FEP film. Subsequently, the electret-treated split yarn was processed as in Application Example 1, and an evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0049] Application Example 6

A polypropylene film (product of Mitsui Petrochemical Ind., Ltd., F301) with a thickness of 30 μm was used as a polymer film and molding was done as in Application Example 1, and an evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0050] Application Example 7

A capton film with a thickness of 50 μm was used as a polymer film, a charge DC voltage of -9 kV was used and a DC voltage of +8.5 kV was applied to the capton film, and molding of an electret filter was carried out as in Application Example 1 and an evaluation was performed for the molding property, and an evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0051] Application Example 8

A porous polypropylene film with a thickness of 30 μm was used as a polymer film, a charge DC voltage of -8.2 kV was used and a DC voltage of +7.2 kV was applied to the porous polypropylene film, and molding of an electret filter was carried out as in Application Example 1 and an evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0052] Application Example 9

A porous polypropylene film (PF5010, product of Ube Kosan Ind., porosity: 50%) with a thickness of 30 μm was used as the polymer film, a charge DC voltage of -8.2 kV was used and a DC voltage of -7.2 kV was applied to the porous polypropylene film, and molding of an electret filter was carried out as in Application Example 1 and an evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0053] Comparative Example 1

The drawn film produced in Application Example 1 was split and subsequently supplied to the electrode and a charge treatment was applied and an electret filter was produced as in Application Example 1. An evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0054] Comparative Example 2

As a polymer film (B), an FEP film was applied to the lower surface of the split yarn but a positive voltage was not applied to the FEP film and an electret filter was produced as in Application Example 1. An evaluation was made of the molding properties and the collection efficiency of the electret filter produced was measured. The results obtained are shown in Table I.

[0055] [0056]

Table 1

Test	Content	Molding properties	Collection efficiency (%)	Variation in collection efficiency
Application Example 1	Reverse charge at the lower surface of the FEP film	..	58.3	4.1
Application Example 2	Reverse charge at the upper surface of the FEP film	..	57.5	3.6
Application Example 3	Reverse charge at the lower surface of the PP film	..	59.1	3.9
Application Example 4	Reverse charge at the lower surface of the capton film	..	57.7	4.3
Application Example 5	Reverse charge at the lower surface of the FEP film	..	63.7	2.0
Application Example 6	Reverse charge at the lower surface of the PP film	..	55.7	3.6
Application Example 7	Reverse charge at the lower surface of the capton film	..	55.4	3.7
Application Example 8	Reverse charge at the lower surface of the PP porous film (Porosity: 20%)	..	55.4	3.4
Application Example 9	Reverse charge at the lower surface of the PP porous film (Porosity: 20%)	..	43.7	3.1
Comparative Example 1	Without film	..	40.6	3.5
Comparative Example 2	Without reverse charge at the lower surface of the FEP film	Δ Discharge observed	51.0	7.1

[0057]

[Results from the Present Invention]

According to the present invention, an electret filter with excellent different properties like a level of collection efficiency that has not been achieved by the methods according to the previous technology, etc., can be manufactured without generating troubles during the manufacturing, at a stable and high yield, and at a fast rate.

[Brief Explanation of the Figures]

[Figure 1]

Figure 1 (a) and (b) are schematic diagrams showing the structure of the equipment used correspondingly in the electro-charge treatment.

[Figure 2]

Figure 2 is a schematic diagram showing the structure of another device used in the electro-charge treatment.

[Figure 3]

Figure 3 is a schematic diagram showing the structure of the equipment used for the measurement of the collection efficiency.

[Explanation of the Symbols]

- 1.....polymer fiber aggregate material
- 2a, 2b.....rolls
- 3a, 3b.....rolls
- 4.....grounding electrode
- 5.....direct electric current source
- 6.....electro-charge electrode
- 7.....roll
- 8.....polymer film (B)
- 9.....direct electric current source
- 21.....aerosol generation device
- 22.....air filter
- 23.....chamber
- 24.....blower
- 25.....flow passing circuit
- 26.....flow rate adjusting valve
- 27.....flow rate meter
- 28.....electret filter
- 29a, 29b.....particle counter

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Claims and Application Examples are from a previous translation.

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